

Initial Plan – Creating an AI to play Othello

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Project Description

Othello (sometimes called Reversi) is a board game where players take turns placing dark or light counters onto an 8 by 8 board, with each colour of counter being used by a different player. When a player places a counter, if the counter forms a horizontal, vertical or diagonal line with any of their colour of counters on the board, any counters of the opponent's colour along this line are flipped to the player's colour. Counters may only be placed at a location if it is within one space of another counter (either vertically, horizontally or diagonally), and only if placing the counter will result in other counters becoming flipped.

The game begins with two light and two dark counters placed in the centre four spaces of the board, and the player using the dark counters goes first. The game ends when neither player can place any additional counters, the winner of the game is the player with the most counters of their colour on the board. (See appendix 1 for example game states)

An Artificial Intelligence (AI) in the context of this project is an intelligent system capable of performing actions and making decisions based on relevant data about the world it inhabits. In a game of Othello, an AI would decide where to place counters on the board based on how much it's total score would increase from the action. ^[1]

The aim of this project is to create an AI that can play a game of Othello with a human player or another AI program. I will also create a recreation of the Othello game that the AI will be able to play programmatically, along with a visual interface for showing and playing the Othello game, to allow human players to play against the AI, and to show the current game state easily.

From my initial research into the project, I have discovered that implementing a Monte Carlo tree search with deep learning into the AI program will be the most promising way to develop an intelligent Othello-playing AI. Thus, I will be creating an AI program that implements the Monte Carlo and deep learning approaches.

The goal of the project is to complete the implementation of the AI described above; if there is abundant time remaining in the project, additional features could be implemented to the program, such as networked game play across two devices, or adapting the AI to play multiple grid-based games.

Project Aims and Objectives

- Completion of an implementation of the Othello game.
 - The game will follow the standard Othello ruleset described in the previous section.
 - The game will provide a programmatic interface to allow an agent, such as an AI, to evaluate and change the game state.
 - The game will have a basic graphical user interface (GUI) that will allow human players to interact with and manipulate the game state.
- Development of an AI program with Monte Carlo tree searching and deep learning capabilities.
 - The AI will be capable of choosing legal moves to play in the Othello game.
 - The AI will use a combination of a Monte Carlo tree search and deep learning to determine the best move to play in a given game state.
 - The AI will likely have various parameters that can be altered to change the performance of the Monte Carlo tree search and the deep learning functions.
- Evaluation of the AI program versus versions of itself, and versus human players.
 - The AI will be capable of beating human opponents in most cases, once it has learned enough moves through its deep learning capabilities.
 - The AI will also be played against alternate versions of itself, which will have different parameters for the Monte Carlo search and deep learning functions/

Work Plan

I have identified the main tasks of the project and determined the time to be spent on each one. The following sections contain a breakdown of the work to be completed for each task, the milestones for the project, and a Gantt chart of time to be spent on each task.

Tasks and Subtasks

1. **Introduction**

As the first task of the main project, I will write the report introduction, and begin working on various supporting sections of the document, such as the table of contents, references, glossary, etc.

2. **Background and Research**

This section covers the writing of the Background section of the final report, along with the research needed for the Design and Implementation sections of the project:

a. **Background Othello and AI Information**

To start the Background section, I will explain the Othello game again, and finalise the rules that will be used for the implementation of it. Additionally, I will explain some terminology related to both Othello and AI.

b. **Researching and Reporting Findings**

To complete the Background section, I will discuss my research on the various ways that other researchers and developers have solved the Othello-playing AI problem, including detailed information on the way Monte Carlo Tree Searching and deep learning works.

As I have covered the Othello background information in this report already, and I have performed preliminary research before undertaking this project, I have allocated a week for this task.

3. **Designing Othello and the AI**

This task represents the time to be spent on writing the Approach section of the final report, including creating user interface (UI) designs and class diagrams.

a. **UI Design**

To ensure the interface created for the game is easy to use and has all the necessary features, I will spend a portion of my time designing and evaluating UI designs for the Othello game.

b. **Class Structure**

I will also create various UML diagrams to show how the different classes link together and interact. These diagrams will be helpful as a roadmap during the following two tasks.

Since the UI will be quite simple, and the class structure should be easy to determine, I expect this task to be completed quickly.

4. Framework Programming

With the preparation work complete, at this point I will be able to move onto implementing the Othello game and its user interface.

a. Othello Game Logic Implementation

This task involves programming the classes to represent the Othello game, along with creating a suitable programmatic interface that will allow the AI program to access and manipulate the game state.

b. Othello UI Implementation

The UI for human players to use will be implemented during this subtask, which will display the game state, player scores, etc.

Due to the amount of work needed to recreate a board game programmatically, plus the additional time needed to ensure the UI is implemented and usable, I have allocated two and a half weeks to this task to ensure that it is completed correctly.

5. AI Implementation

Once the Othello game has been programmed, the process of creating the AI and its advanced functions can begin.

a. Basic AI Implementation

This subtask covers the process of producing a basic Othello AI without any advanced functions, which can then be built on as the project continues.

b. Monte Carlo Search Implementation

This subtask involves the implementation of the Monte Carlo Tree Search algorithm, one of the key elements behind an intelligent Othello AI.

c. Deep Learning Implementation

The other main component for an intelligent Othello AI is ensuring it is capable of learning from previous games, which will be implemented during this subtask.

d. Testing

Though I will be developmentally testing the game and the AI program, I have set aside this time for ensuring the Othello game, user interface and AI program operate as intended before beginning the next task.

Since this task will require the understanding and implementation of many different technologies, I have given a large amount of time for this task to be completed.

6. Evaluation of AI Capabilities

This section will cover all the work necessary for the Results and Evaluation section of the final report.

a. Playing AI vs AI

In this subtask, I will carry out an experiment on how the parameters for the Monte Carlo search and deep learning affect the performance of the AI when played against another AI program instance with different parameters.

b. Playing AI vs Human Players

In this subtask, I will determine how intelligent the AI is when faced with human players.

c. Analysing the Data

Once the necessary amount of data has been gathered from the experiments, I will analyse the data and discuss the results in the report.

I predict that I will only need a week to gather all the data I need, but extra time has been added to ensure the deep learning algorithm has enough previous data to work with.

7. Report Completion

The final task of this work plan encompasses the completion of the remaining sections in the final report.

a. Future Work, Conclusions and Reflections Writeups

This subtask involves completing the final three sections of the report, which will discuss potential improvements to the AI program, the discoveries made over the course of the project, and a reflection on the work I have done .

b. Proofreading and Finalising Report

As a final subtask, I will thoroughly examine the report to ensure all written sections are of a high quality, all figures, data and references are correct, etc.

This task will contain a lot of written work, along with a thorough examination of the whole report, so I have allocated it the remaining project time after the evaluation.

Milestones

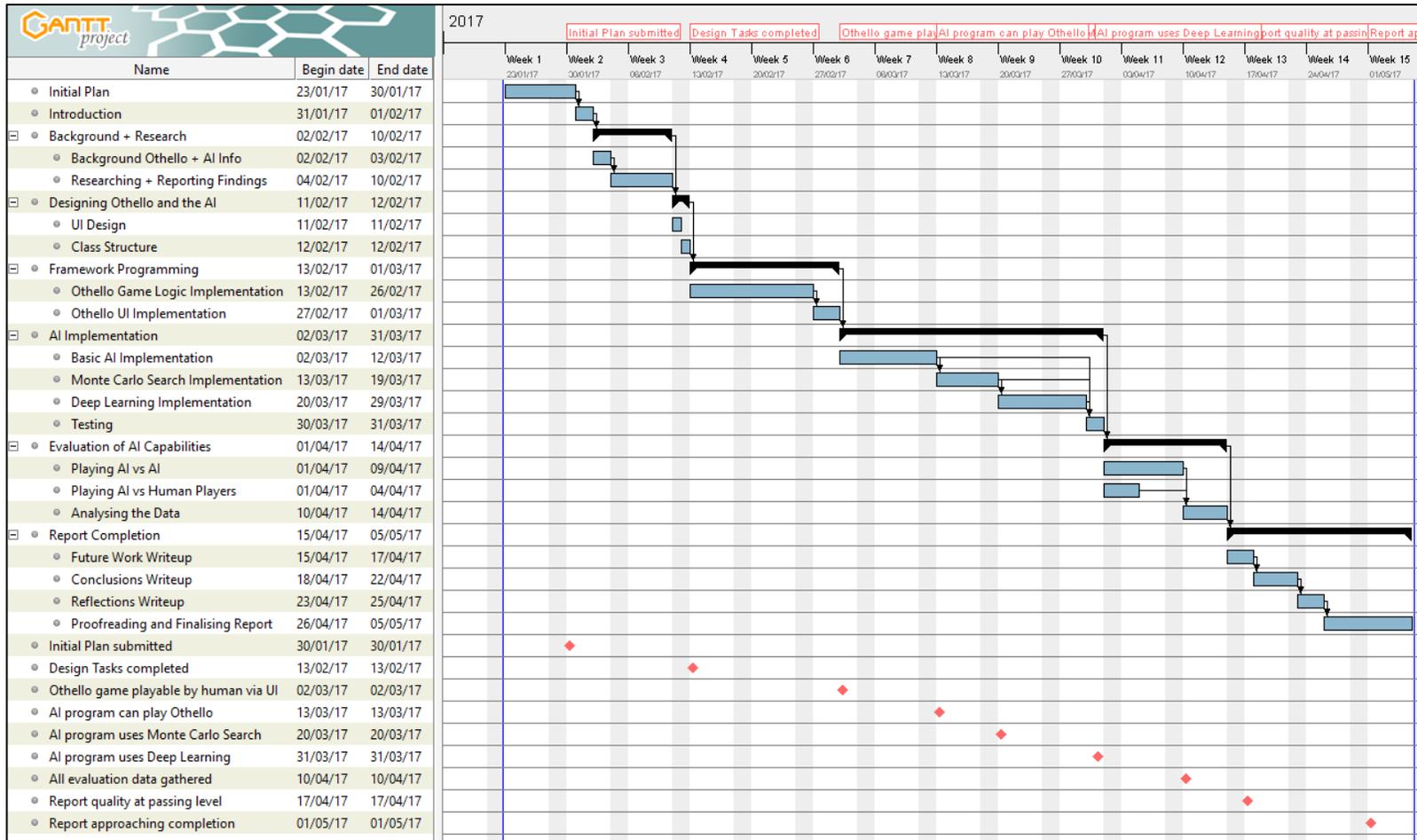
I have also identified key milestones in the project. Since I will be meeting with my supervisor on the Monday of each week, I have placed most milestones on Mondays, so that they can be used to determine how well the project is progressing.

1. **Initial Plan Submission** (30th January) – Submission of this initial report.
2. **Design Tasks Complete** (13th February) – All non-programmatic preparation work for the AI implementation should be complete.
3. **Othello game playable by human via UI** (2nd March) – Othello game logic and UI should be complete at this stage.
4. **AI program can play Othello** (13th March) – AI will be able to play Othello at a basic level.
5. **AI program uses Monte Carlo Search** (20th March) – The AI's Monte Carlo Search should be complete at this point.
6. **AI program uses Deep Learning** (31st March) – AI should be capable of deep learning at this point.
7. **All evaluation data gathered** (10th April) – Experiments of AI vs AI and AI vs Human should be complete and ready for analysis.
8. **Final report quality at passing level** (17th April) – At this point, if the report is submitted, then a passing mark should be obtainable.
9. **Final report approaching completion** (1st May) – Report should have all sections completed, with only proofreading and final checks to complete.

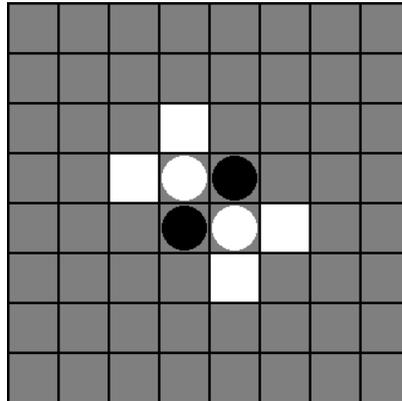
As for review meetings, these dates are suitable points to assess the projects progress:

- **13th February** – Design task milestone and framework implementation begins on this date; will be a good time to assess the project's pace.
- **20th March** – Game, AI and Monte Carlo should be implemented by this point; meeting can be used to assess if remaining milestones will be met.

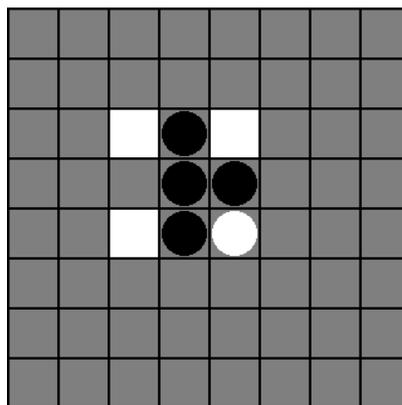
Gantt Chart



Appendix 1 – Example of Othello Game States



An initial set up of the game; white squares are where the dark player can potentially place counters, (as they play first) while grey squares are where counters cannot be placed until the game state changes (or because counters already exist there)



A state following on from the initial state, where the dark player has placed a counter, resulting in a light counter being flipped to dark. The white grid squares show where the light player can place a counter.

Example layouts used found at: <https://en.wikipedia.org/wiki/Reversi>

References

[1] Hammond, Kris. 2015. "What is Artificial Intelligence?". Available at: <http://www.computerworld.com/article/2906336/emerging-technology/what-is-artificial-intelligence.html>. Last accessed 23rd January 2017.